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DIVERSITY IN N.W. HIMALAYAN MACROFUNGI (BASIDIOMYCETES) AND THEIR CONSERVATION

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ABSTRACT

The diversity and distribution of macrofungi belonging to Jelly fungi, Agaricales, Aphyllophorales and Gasteromycetes in N.W. Himalayas, based on extensive survey and collections of these fungi from this region have been discussed in the present communication. An emphasis is laid to intensify the survey and identification of taxa and habitats worthy of conservation, leading to ascertain the exact status of species. The paper discusses the various threats to which not only the fungi but their habitats are also constantly exposed, and suggests the strategies for their effective conservation. The problems faced in evolving the parameters towards the preparation of Red Data lists/Books on fungi have also been discussed and possible remedies to overcome them are outlined.

INTRODUCTION

The majority of non-flowering plants are classified as fungi. They constitute a group of heterotrophic organisms, subsisting as parasites or as saprophytes on other organisms or their residues. In most the vegetative body consists of fine threads or hyphae which together form the mycelium with well defined nuclei. The fungi number more than 5000 genera (*ca* 2200 monotypic) and approximately 1,20,000 species (Stace, 1984, Prance, 1978), all over the world as compared to India's *ca* 2300 genera (800 monotypic) and approximately 13,000 species out of which *ca* 3000 are endemic to India.

Basidiomycetes including *ca* 800 genera (*ca* 250 monotypic) and more than 18000 species in the world (*ca* 500 genera, 140 monotypic, more than 3200 species, *ca* 450 endemic in India), is one of the largest groups of macromycetes and is of worldwide in distribution. A perusal of collections made by the author as well as others and deposited in different herbaria *viz.* HCIO, DD, BSD and PAN and literature reveals a very interesting and diversified flora of macrofungi in N. W. Himalayas. In the present communication, a concise account of distribution, ecology, endemism and host specificity for macrofungi (only Jelly fungi, Agaricales, Aphyllophorales and Gasteromycetes) in this area and the conservation of fungi in general have been discussed.

The N. W. Himalayas extend between 29°-35°N latitudes and 74°-81°E longitudes (approx. 800 km long and 150-200 km broad) convering the states of Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh and part (foothills) of Punjab and Haryana. The climate is tropical in the foothills and up to 1000 m in the outer ranges, sub-tropical between 1000-2000 m, temperate between 2000-3000 m (-3500 m) and alpine from 3000 m to the snowline at 4500 m. Forests do not extend beyond 3600 m and the alpine zone mostly consists of meadows and scrub vegetation.

Jelly fungi : Jelly fungi found frequently in the tropical zones represent a small group of conspicuously gelatinous species having variable shapes and colour. *Auricularia auricula* (Jews ear fungus), *A. polytricha* ; *Calocera potentillae* (orange yellow clubs); *C. viscosa* (bright yellow branched clubs) ; *Tremella mesentricha* (yellow pendent, brain like masses); *T. fuciformis* (reddish brown foliose masses) ; *Dacrymyces stillatus*

(Pustular or cup-shaped yellow or orange masses); *Exidia glandulosa* and *E. bursaeformis* (disc-shaped, stalked or pendulus fruitbodies) are commonly found on dead fallen branches, cut stumps, and damp timber of mostly deciduous woods. *Heterochaete mussooriensis* is endemic.

Agaricales : The large order Agaricales includes Basidiomycetes with mostly fleshy fruitbodies. Having more than 110 genera and 650 species in India, are richly represented in N.W. Himalayas. *Cantharellus* and *Craterellus* are dominant genera of Cantharellaceae with tubular or infundibuliform, membranous, toughish basidiocarps having smooth to wrinkled or strongly folded hymenophore. *Cantharellus cibarius* (egg yellow basidiocarps) grows in pine forests and is collected for sale in the markets. *C. congregatus, C. infundibuliformis* and *C. minor* are other frequently growing temperate species growing on humus. *Craterellus cornucopioides* (sooty brown to black basidiocarps) is edible and is very common amongst fallen leaves in deciduous woodlands. *C. cymatodermoides* and *C. musooriensis* are endemic to W. Himalayas. *C. odoratus* and *C. sinuosus* are the other common temperate species.

Pleurotus, Lentinus and monotypic *Schizophyllum* are also well represented genera with their position controversial between Aphyllophorales and Agaricales. *Pleurotus* has more than 15 lignicolous species forming solitary or clustered, tough, fruitbodies with eccentric or lateral stems. *P. anserianus, P. flabellatus, P. cretaceus* and *P. membranaceous* are common on dead woods in the tropical areas. *P. placentodes* - a beautiful white species prefers *Betula* stems. The edible *P. ostreatus* has a wider range of distribution from sub-tropical to *Betula* forests in W. Himalayas. It grows on dead stumps of *Euphorbia royleana* at lower altitudes and on both living and dead tree trunks especially of *Betula* and Beach at higher altitudes. Other common and edible species are *P. salignus, P. epus, P. dryinus. Lentinus* has tough, persistent and firm textured basidiocarps, growing abundantly on dead woods particularly in tropics. *L. velutinus, L. strigosus* and *L. squarrosulus* are amongst the most common species. *L. connatus* forms large imbricate masses and is nearly always found on decaying wood on forest floors. *L. lepideus* grows in clusters on coniferous stumps. *L. tasciatus, L. hookerianus* and *L. melanophyllus* are common on stumps of *Shorea* and *Mangifera. Schizophyllum commune* having worldwide distribution grows parasitically or saprophytically on many deciduous trees. The caespitose basidiocarps are easily recognised by the leathery, flabelliform pilei which are deeply cleft, and the longitudinally divided lamellae becoming revolute in dry weather. Its ability to withstand the xerophytic conditions allows the species to persist throughout the dry season and it is undoubtedly one of the commonest fungus in tropical zones.

Family Tricholomataceae forms a dominant element of Agarics in both tropical and temperate zones and are mostly lignicolous or terrestrial. Species of genera like *Collybia, Mycena* and *Marasmius* show a considerable range of variation and speciation. Among the parasitic mushrooms *Armillaria mellea* is the most common and damaging, growing in tufts with a well developed annular ring on a variety of hosts from tropical to temperate zones. *A. fuscipes* is parasitic on *Acacia decurrens* while *A. horrens* is common on the bark of many living trees in temperate areas. Among the other species growing on dead woods are *A. adepha, A. multicolor, A. duplicata* and *A. vara. Nyctalis parasitica* is a rare species with a bell shaped, lilac grey basidiocarps and distorted gills, growing clustered on *Russula nigricans* and *R. annulata* in the tropics only.

Laccaria laccata having bell-shaped, stipitate, reddish brown basidiocarps with striate margins and waxy gills is common throughout the deciduous forests. *Clitocybe* has funnel-shaped basidiocarps and decurrent gills and prefers leaf litter. *C. flaccida, C. excentrica, C. laccata* and *C. nebularis* are some common species in tropical forests. *Tricholoma giganteum* and *T. gambosum* are whitish, edible and common in pastures and roadsides in plains while *T. cremoriceps* and *T. terreum* grow on dead tree trunks in temperate forests. *Xeromphalina campanella* grows on dead woods. *Collybia* is represented by more than 10 species of humicolous or lignicolous mushrooms. *C. dryophylla* (yellowish) among the mosses and *C. maculata* (reddish brown) in coniferous woodlands are common and widely distributed. *C. albuminosa* is found rarely on termite nests. *Lepista sordida* on dung and *L. glabella* on compost heaps are rare in tropical zones. The rare *Calocybe indica* is edible.

Marasmius is a varying genus of lignicolous, folicolous and humicolous species having worldwide distribution and growing abundantly in tropics. *M. rotula, M. cohaerens, M. caperatus* and *M. consocius* are common on dead rotting twigs while *M. echinosphaerus* grows on stems of many living trees. The well known and edible *M. oreades* forms fairy rings in tropical grasslands and gardens. *Mycena* species have small, delicate, conical or bell shaped cap borne on fragile elongated stem. *M. galericulata, M. galopus, M. epipterygia, M. aetites* and *M. inclinata* are densely tufted on dead old stumps or buried wood. *M. orata* and *M. pura* are common amongst mosses.

Amanitaceae is well represented in N. W. Himalayas by the specialized genera like *Amanita, Termitomyces, Pluteus, Volvariella,* etc. *Volvariella volvacea* (volva at the base of stem) is the common paddy straw mushroom while *Termitomyces radicatus* and *T. microcarpus* are common on termite mounds in tropical areas. *Amanita* is among the most important Agarics having fleshy, small to large basidiocarps with a free volva or a friable remains at the stipe base and the pileus. Amanitas are the most poisonous species known (about 1%). Deaths caused by fungus eating are in the great majority of cases is due to three closely related species *i.e. A. muscaria, A. pantherina* and *A. phalloides,* all common in deciduous, mixed and coniferous forests. Some other common species occurring in temperate areas are : *A. regalis, A. vaginata* and *A. caesarea. Pluteus cervinus* (edible) grows in tropical zones while *P. chrysopraseus* and *P. cuspidatus* are frequently met in the temperate forests on soil and rotting stumps. *P. palumbianus* is a parasite on living tree trunks.

Hygrocybe and *Hygrophorus* are the prominent members of the family Hygrophoraceae and are known by their vivid colours and convex to conical caps with widely spaced gills. *Hygrocybe miniata, H. conica, H. fulvus, H. fornicata, H. hobsonii* and *H. pomova* (all with reddish to yellow basidiocarps) are common in grasslands in pine forests. *Hygrophorus chrysodon* and *H. pustulatus* are common temperate species on grass. *H. goetizii* is one of the snow bank mushrooms in W. Himalayas.

Agaricus and *Lepiota* (Agaricaceae) are more frequent in the tropics both in numbers and in terms of species diversity. *Agaricus* (membranous ring on the stem) has more than 10 species in W. Himalayas. Some edible and commonly seen species are : *A. placomyces, A. xanthodermus, A. arvensis, A. campestris* and *A. elevensis. A. arvensis* forms fairy rings. *A. bisporus* is a widely and commercially cultivated species. Species of *Lepiota* are particularly common in tropics and mostly have a delicate pileus with scales on pilear surface and stipe base. *L. cristata, L. procera. L. mimica, L. puellaris, L. mammosa* and *L. punica* are commonly met in the lowland forests, growing on plant debris. The rare *Cystoderma amianthinam* is found among mosses and grass in oak forests.

The family Coprinaceae is represented by such large tropical genera as *Coprinus, Psathyrella* and *Panaeolus. Coprinus atramantarius, C. disseminatus, C. domesticus* and *C. micaceus* grow in dense clumps near the base of standing trees, cut stumps or decaying wood. *C. commatus* grows on a variety of host, ranging from dung to refuse or garden soil. *C. micaceus, C. commatus* and *C. atramantarius* are edible. *Panaeolus* spp., have corn like caps with a tall delicate and narrow stem, *P. indica, P. cyanescens* growing on dung, and *P. campanulatus,* on grassy grounds, are common tropical species. *P. semiovatus* grows on compost of edible mushroom. *Psathyrella gracilis*, with dark gills edged with pink, is found growing in tufts among the grass or leaves in deciduous forests or hedge bottoms. *P. hysipoda* on bark of living trees and *P. prona, P. hydrophora* and *P. empyreumatica* on dead wood are seen up to sub-tropical zones.

Majority of the species of family Bolbitiaceae are humicolous, lignicolous or coprophilous occurring in tropical to temperate forests. *Bolbitius flavellus, B. acer, B. tener* and *B. grandiusculus* have thin pubescent and viscid pilei associated with dung heaps or humus. *Conocybe siennosphylla, C. tenera* and *C. zeylanica*, with large basidiocarps and sub-bulbous base, are quite rare. *Agrocybe cylindracea* grows in temperate forests.

Family Strophariaceae is represented by genera like *Stropharia, Hypholoma, Psilocybe*, etc. *Stropharia* spp., have strongly glutinous caps and a prominent ring or ring zone on the stipe. *S. semiglobata, S. aurivella, S. psathyroidea* and *S. merdaria* are seen on grassy grounds in the tropical areas. *Hypholoma* spp., grow mostly in tufts. *H. fasciculare, H. capnoides* and *H. sublaterium* are quite frequent on dead woods in sub-tropical to temperate forests. *H. velutinum* and *H. hemisodes* grow near earth banks. *Psilocybe albobrunnea, P. coprophila* and *P. caespiticia* are rare in tropical areas.

Cortinariaceae includes terrestrial or lignicolous often mycorrhizal mushrooms, which are largely found in the temperate areas and are far less common in the tropics. This is atleast partly due to the ectotrophic relationships known to exist with certain forest trees, which are not present in the tropics. The genus *Cortinarius* has many species with a cobwebby cortina (ring zone). Commonly found species growing mycorrhizically with higher plants in the temperate forests are *C. flammeus, C. caniosus, C. vinosulus* and *C. violaceus*, *Pholiota* includes mostly lignicolous species having smooth or scaly, bright yellow caps. *P. aurivella* and *P. examinans, P. destruens* are fairly common on rotting tree trunks. *P. squarrosa* and *P. gollani* are parasitic on many species of deciduous trees in the temperate forests. *Galerina mutabilis* and *G. sapineus* grow in tufts at the bases of stumps. *Naucoria micromegala* grows among mosses and grasses. *Galera zeylanica* and *G. lataritia* are commonly found on grassy grounds while *G. vinolenta* and *G. tenera* grow among the mosses on living or dead trees. *Inocybe echinata, I. flocculosa* and *I. holophlebia* are quite rare. *I. indica, I. peglerii*, and *I. ochrorufa* are endemic to Himalayan temperate forests. *Crepidotus* and *Tubaria* represent the family Crepidotaceae. *Crepidotus alveolus* and *C. applantus* (Both white with lateral stipes) and *Tubaria furfuracea* are common tropical species on bark of dead trees. *Entoloma* is the only comparatively better known genus of the family Entolomataceae and include rather robust, fleshy, terrestrial fungi with sinuate gills. *E. cystopodium* and *E. euthelum* grow among mosses in temperate forests. *Ecclilia blandfordii* and *E. griseo-rubella* are quite rare and prefer grass in garden soils. *Nolanea* is an interesting genus having mammillate or papillate pilei. *N. nana* and *N. mammifera* are rare and grow on litter in tropical zones. *Clitocybe* a small genus is usually associated with compost of cultivated mushroom.

Paxillus (Paxillaceae) has all its 5 species distributed from temperate to alpine forests. *P. chrysitea, P. sulphureus, P. pinguis* and *P. panuoides* are common on ground or dead woods. *P. involutus* (the roll rim) is associated with *Betula* at higher altitudes.

The Russulas (*Russula* and *Lactarius*) are the most beautiful and coloured agarics distributed both in grasslands and forested areas of W. Himalayas. *Russula* with its basidiocarps brilliantly coloured in shades of pink, red, orange, yellow, etc., and brittle gills, is one of the largest of agarics genera having over 40 terrestrial and mycorrhizic species. *R. emetica, R. sardonia, R. caerulea, R. nauseosa, R. sanguinea, R. cyanoxantha* and *R. delicta* are common in temperate to subalpine forests. *Lactarius* has small to robust milky caps. *L. vellereus* (distant gills) and *L. piperatus* (crowded gills) with hot and peppery juice are common in deciduous forests. *L. rupus, L. stramineus* and *L. deliciosus* (Carrot-like milk turning green on exposure) are found in pine forests. *L. turpus* prefers *Betula* sp., while *L. crysorrheus* (milk turns yellow on exposure) is quite common in oak forests. *P. subalpina* and *L. subresimus are* common snowbank mushrooms. *R. emetica, R. atropurpurea, R. fragilis* and *L. piperatus* are among the most poisonous species of mushrooms. *R. emetica* and *L. piperatus* are prominent mycorrhizae-forming species with Poplars, Oaks and Birches. *Russula himalayana, R. mussooriensis, R. schaefferina* and *Lactarius himalayana* are endemic to Himalayas.

Boletes are the intersting members of the fleshy fungi having many tiny pores on the underside of a sponge-like cap and a central stalk. They form ectotrophic mycorrhizae with conifers and other deciduous trees in the temperate to subalpine zones. *Boletus* has more than 20 species in W. Himalayas. *B. areolatus, B. delphinus, B. pussilus, B. scrobiculatus, B. flavipes* and *B. edulis* are very common temperate species. *B. gigas* is common in *Betula* forests. *B. erythropus* and the rare *B. satanas* (with blood red pore surface) and *B. badius* and *B. chrysenteron* (yellow pore surface) turn their flesh/pore surface to blue or greenish on exposure/bruising. A very rare *B. parasitica* is a parasite on *Scleroderma citrinum*. *B. edulis* is edible. *Suillus* species have viscid to glutinous pileus and glandular stipe with or without a ring, growing frequently in pine forests mycorrhizically. *S. luteus, S. grevillei* and *S. granulatus* are the commonly met species. *Leccinum scabrum, L. versipellis* and *L. ustale* (stem covered over major part with small to large back scales) form mycorrhizae with Poplars, Oaks and Birches. *Gyroporus castaneus* (chestnut brown caps with white hymenophore), *Strobilomyces floccopus, S. nigricans* (with blackish grey basidiocarps covered with thick scales) and *Boletellus emodens* (yellowish to reddish hymenophore bluing on bruising) are frequently seen in the temperate forests. *Xerocomus baksii* and *X. indicus* are endemic to W. Himalayas.

APHYLLOPHORALES

Include those fungi whose basidiocarps are not soft and putrescent. They are represented by more than 200 genera (50 monotypic) and approx. 800 spp. (50 endemic) in N.W.Himalayas. Thelephores, probably are the most primitive forms of Aphyllophorales. Known by more than 1200 species from all over the world, they have *ca* 100 genera (10 monotypic) and more than 250 species spread over families like : Corticiaceae, Stereaceae, Lachnocladiaceae, Echinodontiaceae, Thelephoraceae, Hymenochaetaceae, etc., in W. Himalayas. Most of the species are lignicolous in the tropical to temperate zones. Out of the 250 or more species reported from this area, 75% are resupinate while the remaining 25% are stereoid.

Tomentella with resupinate, arachnoid to floccose basidiocarps (more than 125 species in the world) is probably the largest genus of Thelephores having not less than 20 species, in W. Himalayas. Some commonly met species are : *T. rubiginosa, T. pilosa, T. epiphylla* and *T. microspora*. *Phanerochaete* has about 8 resupinate species and *P. filamentosa* with yellow to orange rhizomorphic fructifications is widely distributed. *P. gigantea* is associated with white rot of conifers. *Metulodontia queletii* with odontoid hymenial surface is common on dead hardwoods. The yellow atheloid fructifications of *Amphinema byssoides* are quite common on the slash under conifers. *Lopharia crassa* and *Gloeocystidiellum luteo-cystidium* are distributed widely in the tropical belts. A few species like *Lopharia cinerascens* and *Lexitextum bicolor* have wider distribution ranging from tropical to temperate or even boreal zone.

Phlebia albida and *P. roumequeri* with membranous to ceraceous fructications, becoming rigid and horny on drying-commonly inhabit logs and stumps of conifers. *Aleurodiscus taxicola* (living tree of *Taxus baccata*) and *A. oakesii* (on

Oaks) are quite rare and confined to temperate zones. *Gloeocystidiellum* with resupinate, smooth to odontoid fructifications has about 5 species in tropical and temperate zones. *G. sulcatum* and *G. lactescens* are common temperate species. *Scytinostroma duriusculum* and *S. portentosum* are common on dead angiospermic twigs while *S. odoratum* is rare. Fructifications of *Peniophora* are resupinate, adnate (less than 200 μm in thickness) and coloured in shades of red, blue to brown or grey. *P. cinerea* and *P. quercina* are seen on the bark of hardwood trees in the temperate zones. *Chaetoderma luna* attacks the freshly cut stumps of conifers causing brown rots.

Hyphodontia arquta and *H. spathulata* have resupinate, floccose to membranous fructifications with tuberculate to toothed hymenial surface and are very common species on dead conifers. *Hyphoderma pubera, H. setigerum* and *H. praetermissum* are also common on dead coniferous woods.

Trechispora is a veriable genus of resupinate to pileate fructifications with smooth tuberculate or poroid hymenial surface. *T. mollusca* and *T. vaga* are common temperate species. *Coniophora puteana* is associated with dry rot of Gymnosperms. *C. betulae* and *C. arida* are high altitude species growing on *Abies, Betula* or *Rhododendron. Serpula lacrymans* and *S. himantoides* (reticulately folded hymenophore) are temperate species on the gymnospermous woods. *S. mollusca* is quite rare. *Amylostereum chailletii* has thick, effuso-reflexed to pileate fructifications and is widely distributed in the coniferous forests of W. Himalayas and causes white rot. *Stereum hirsutum* (hirsute pileus) *S. sanguinolentum* (on conifers) and *S. gausapatum* (on Oaks) with bleeding hymenium are the widely distributed species and are serious parasites infecting heartwood of many living trees in Himalayas. *Xylobolus subpileatus* and *X. frustulatus* cause white pocket rots to hardwoods and conifers respectively. *Chondrostereum purpureum* is known to cause silver leaf diseases of apples and other fruit trees in temperate zone. *Sparassis crispa* or the "bath sponge fungus" grows usually at the base of pine or other deciduous trees (probably mycorrhizic) in the temperate forests.

Hymenochaete, Vararia and *Astrostroma,* the non-poroid genera of the family Hymenochaetaceae are widely distributed on dead rotting woods. *Hymenochaete tabacina, H. rubiginosa, H. mougeotii, H. leonina* and *H. fusco-badia* are common temperate species. *Vararia rhodospora* is the commonest resupinate fungus in the coniferous forests. *V. pallescens* and *V. effuscata* on dead woods are quite rare. *Asterostroma cervicolor* and *A. musicolum* are well represented in the temperate and subalpine zones.

Some other rare and smaller genera having representation in the Himalayan Mycoflora are : *Basidioradulum, Radulomyces, Radulodon, Irpiciporus, Pulcherricium, Dacrybolus, Confertobasidium, Galzinia, Epithele, Xenasma, Subulicystidium, Cristinia, Tubulicrinis,* etc.

The Hydnaceous or the Hedgehog fungi (*ca logenera,* 40 species, 10 endemic) produce their basidia on spines or tooth-like projections which point downwards. Among the widely spread and frequently occurring species are : *Auriscalpium vulgare* (slender, erect stalk and kidney shaped cap) on burried cones, and *Hydnum repandum* (fleshy stipitate, pale orange to flesh coloured) on ground in temperate forests. *Echinodontium japonicum* produces hard, woody parennial fruitbodies and is fairly common on bark of Oaks. *Resinicium bicolor, Steccherinum fimbriatum, S. ochraceum, S. laeticolor* are other common W. Himalayan species. *Hericium erinaceus* and *H. coralloides* are the most beautiful of hydnums with massive pure white and intricately branched fruitbodies having spines up to 6 cm long and growing parasitically on beach and other deciduous trees. *Sarcodon scabrosus* (pale yellow to brick-red) is found on soils in temperate forests. *Hydnum repandum, Hericium erinaceus* and *H. coralloides* are eaten by local people. The clavarias or the coral fungi have more

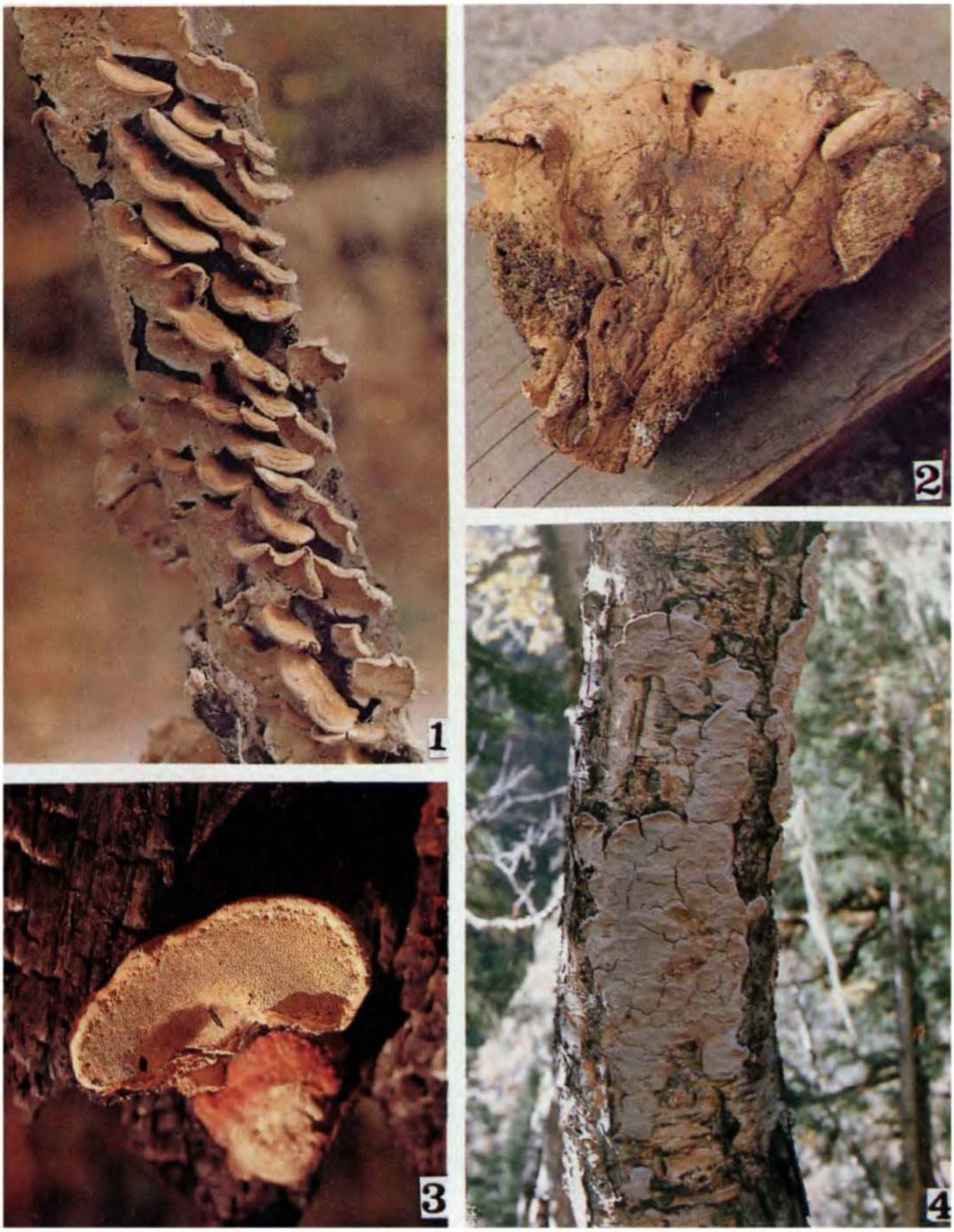

Plate-1 (1-4) : 1. *Trametes Varsicolor* (Fr.) Pilat - Widely distributed and common on dead hardwoods from temperate to subalpine zones. 2. *Bondarzewia berkeleyi* (Fr.) Bond. & Sing. - A very rare temperate species on the roots of deciduous trees. 3. *Fomitopsis rosea* (Fr.) Karst. - A common temperate polypore on conifers especially burnt *Abies* stumps. 4. *Phellinus laevigatus* (Fr.) Bourd. & Galz. - Widely effused only on living and dead *Betula* tree trunks.

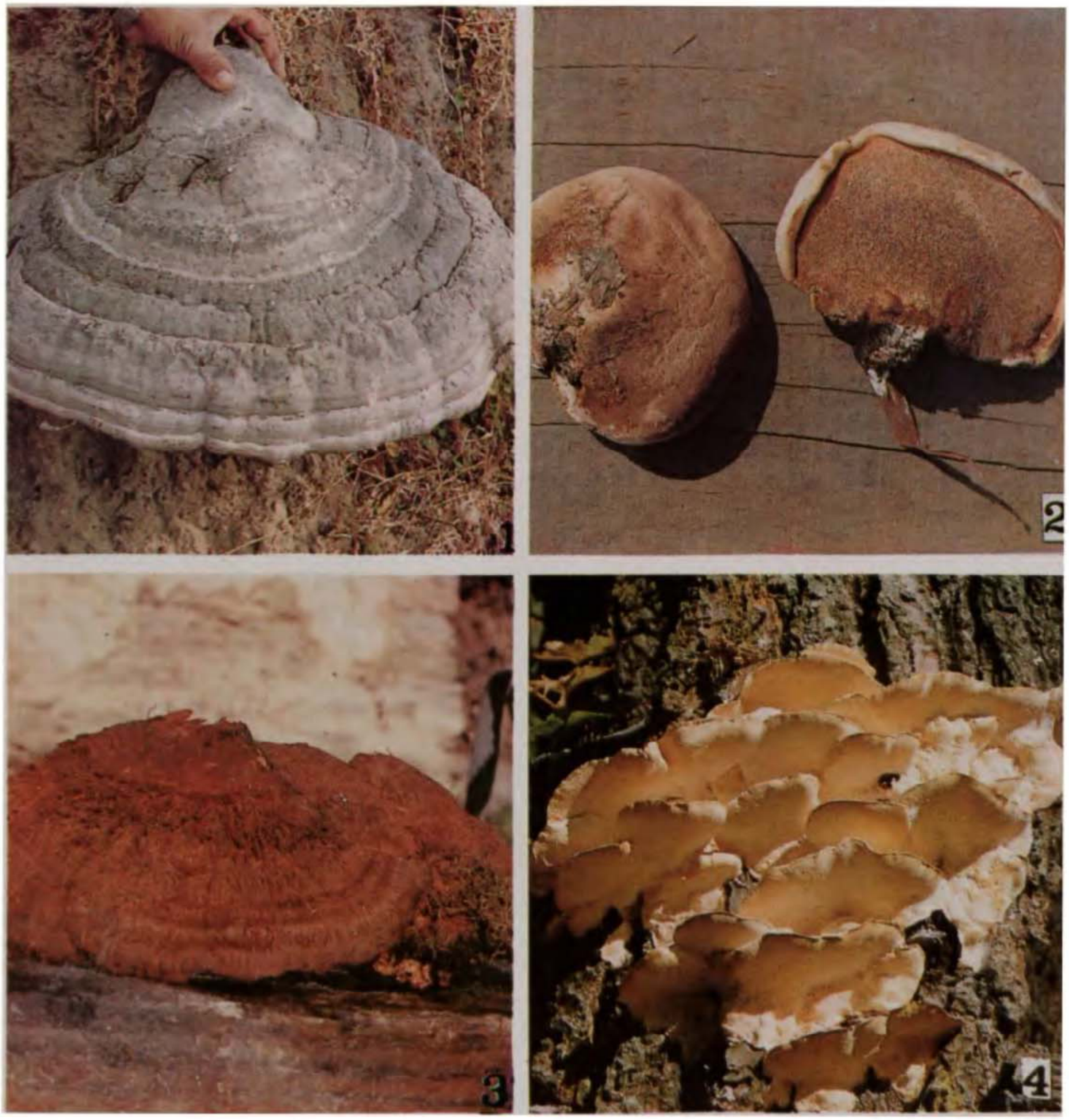

Plate - 2 (1-4) : 1.*Fomes fomentarius* (Fr.) Kickx. - The massive fruitbodies are very common on Oaks up to subalpine forests. 2. *Piptoporus betulinus* (Fr.) Karst. A very rare species growing exclusively on *Betula utilis* above 12000 ft. 3. *Inonotus cuticularis* (Fr.) Karst. - A common temperate polypore on Oaks. 4. *Heterobasidion insulare* (Murr.) Ryv. - A very common temperate polypore growing preferably on Confiers.

than 15 genera and 60 species in W. Himalayas. *Typhula ovata* (yellowish clubs), *Ramaria stricta* and *R. apiculata* (pale yellow to orange, densely branched), *Clavulinopsis corniculata, C. fusiformis* and *Clavulina cristata* (all with ultimate branches tending to be cristate) and *Clavulina cinerea* (coral-like with ultimate branches blunt) are some of the widely distributed and commonly met clavarias in the temperate Himalayan zones. *Clavaria indica* an endemic species of W. Himalayas is very interesting with dark brown to black fructifications. Some clavarias growing luxuriantly and edible among the natives are : *Ramaria apiculata, R. aurea, R. botrytis, R. botrytoides, R. flava, Clavariadelphus mirus,* and *Clavaria vermicularis.*

Polypores, the most important group of wood-rotting fungi are represented by more than 100 genera (15 monotypic) and about 400 species in India.

In the family Hymenochaetaceae (Xanthochroic series), *Phellinus* is the largest and most diverse of all polypore genera and has more than 200 species all over the world (*ca* 60 in India, 35 in WH). The following species are obligate parasites in the plains (tropical zones) : *P. adamantinus, P. badius,* (heart rot of khair), *P. rimosus, P. fastuosus* (serious heart rot of *Shorea* and *Terminalia*), *P. senex* (wound parasite especially on the trees of Meliaceae), *P. merrillii, P. punctatus* and *P. caryophylli* are commonly seen on the dead/living branches of standing trees. *P. pachyphloeus* is the most serious parasite on many trees, especially Mango and *Ficus* in the foothills and its basidiocarps are the biggest among the polypores (up to 50 cm × 50 cm × 10 cm). *P. noxius* a common species in Northeast and South India is not seen in W. Himalayas.

In the second group are the species which have a wider range of distribution i.e. from tropical to temperate or even up to subalpine zones. *P. conchatus,* on dead branches of Mango, *Salix* and *Pyrus, P. gilvus* and *P. contiguus,* on many dead woods, and *P. pectinatus* as parasite on many hard woods, are common.

In the third group are the species growing in temperate zones. *P. allardii* and *P. xerantius* (bright yellow pore surface) on dead/living Oaks, *P. pini* causing serious heart-rot of living pines, *P. robustus* on living/dead *Abies* or *Picea* and *P. ignarius* on *Viburnum* are the frequently met polypores in this zone. *P. linteus, P. extensus* and *P. sanfordii* are quite rare.

There are a few species characterisic of *Abies-Betula* zone *P. laevigatus, P. nigricans* and *P. lundelli* are common species of this zone. *P. acontextus* - a rare species parasitizes *Rhododendron lepidotum* in W. Himalayas.

Inonotus is an interesting genus with its 20 or so species mostly confined to the temperate and subalpine zones on both dead/living hosts (usually *Quercus* and *Betula*). *I. patoullardii, I. subhispidus* and *I. hispidus* are common in temperate zones. *I. dryadeus* (weeping polypore) with its massive basidiocarps is commonly found at the bases of Oaks/Abies trees. *I. sciurinus* reported from Japan is present abundantly on dead hardwoods. *I. diverticulosa* on Oaks is endemic to W. Himalayas. *I. radiatus* and *I. tenuicarnis* are widely distributed from sub-tropical to subalpine zones on Oaks, *Abies* and *Betula. I. tomentosus* and *I. circinatus* are common in pine forests probably growing parasitically on roots. *Coltricia perennis* is the only temperate polypore demonstrated to be mycorrhizic with flowering plants.

Among the other commonly met Hymenochaetaceons species in the foothill zones are : *Aurificaria indica, A. luteo-umbrina* (both serious parasites on hardwood trees), *A. shorea* (only on *Sal*), *Cyclomyces tabacinus, Coltricia cinnamomea* and *Phylloporia ribis* (especially on *Murraya*). The massive reddish brown fruit-bodies of *P. weberiana* are common on dead woods or living Oaks in the tempeate zones.

The following species of polyporaceae (non-xanthochroic) are common in the tropical zone :

Amylosporus campbelli, (probably parasitic on grass roots), *Coriolopsis telfarii* (most common), *C. floccosa, C. aspera, C. caperata; Earliella scabrosa* (most common) ; *Grammothele delicatula; Hexagonia tenuis, H. apiaria; Loweporus tephroporus; Nigrofomes melanoporus; Nigroporus vinosus, N. durus; Pachykytospora papyracea* and *Tinctoporellus epimiltinus.*

Following species of polyporaceae are cosmopolitan and grow from tropical to temperate zones :

Antrodiella semisupina, A. liebmanii, Bjerkendera adusta, Ceriporia viridans ; Daedalea incana; Datronia mollis; Dichomitis leucoplacus; Favolus brasiliensis; Fomitopsis dochmius, F. palustris; Gloeophyllum abietinum, G. subferugineum; Gloeoporus dichrous ; Incrustoporia carneola; Irpex lacteus; Junghunia nitida; Laetiporus sulphureus (Bright yellow, edible) ; *Lenzites acuta, L. betulina; Microporus affinis, M. xanthopus; Oxyporus spiculifer, O. ravida, O. populinus; Perenniporia fulviseda, P. medulla-panis, P. ochroleuca, P. tenuis; Polyporus varius, P. grammocephalus, P. arcularis, P. brumalis; Pycnoporus sanguineus; Pyrofomes albomarginatus* (*Shorea* only); *Rigidoporus lineatus, R. microporus, R. ulmarius, R. vincta; Schizopora paradoxa, S. flavipora; Tramates cingulata, T. cotonea, T. gibbosa, T. hirsuta; T. lactenea, T. tephroleuca; Trichamptum byssogenus, T. biformis, T. abietinum, Tyromyces chioneus* and *Writoporia lenta.*

Following species of polyporaceae occur in the Temperate and Boreal zones :

Albatrellus dispansus, A. confluens and *A. ovinus; Antrodia albida, A. carbonica, A. gossypina, A. lenis, A. serialis, A. oleracea, A. albobrunnea; Boletopsis subsquamosa; Ceriporiospsis rivulosa; Cerrena unicolor; Daedaleopsis confragosa; Diplomitoporus rimosus; Fomes fomentarius* (very common); *Hapalopilus nidulans; Heterobasidion insulare* and *H. annosum; Oligoporus fragilis, O. leucospongia, O. tephroleucus; Phaeolus schweintzii ; Skeletocutis amorpha; Spongipellis delectans, S. unicolor* and *Fomitopsis rosea.*

Among the very rare and interesting species present are : *Daedaleopsis purpurea, Fistulina hepatica* (edible), *Piptoporus betulinus* (on *Betula* only), *Bondarzewia berkeleyi* and *Piloporia indica.* Some species like, *Laetiporus sulphureus, Polyporus badius* and *P. arcularis* are eaten by the local people.

Ganoderma lucidum and *G. applanatum* are wound parasites on a variety of host plants, from tropical to temperate zones. *Amauroderma rugosum* grows on ground at lower altitudes.

Genera like *Amylosporomyces, Lutypa* and *Cystostiptoporus* are endemic.

Some more species of Aphyllophorales endemic to W. Himalayas are : *Tomentella subcorticioides, T. himalayana, T. indica; Coniophora dimitiella, C. cordensis; Dentipellis subseparans; Gloeocystidiellum donkii, Scytinostroma rhizomorpharum; Vararia brevispora; Stereum acanthophysatum; Ceratobasidium subatratum; Botryobasidium subbotryosum; Sistotrema lachrymispora; Xenasma subclematidis, Aleurodiscus taxicola; Amylocorticium indicum, Amylosporomyces fibuligera; Leptosporomyces globosum; Chondrostereum himalaicum; Metulodontia indica; Hyphodontia longicystidiosa, H. subdetritica, Ramaria brevispora, R. camelicolor, R. clarobrunnea, R. flaviceps, R. flavoviridis, R. leavispora, R. pura, R. rubrogelatinosa; Typhula longispora; Mucronella subalpina; Clavulinopsis moricolor, C. punicea; Clavulina mussoriensis, C. limosa, C. hispidulosa; Hymenochaete fuscobadia* and *Cystostiptoporus indica.*

GASTEROMYCETES

These fungi have basidiocarps where the hymenium remains closed atleast until the spores are released from the basidia and include Puffballs, Earthstars, Stinkhorns and Birds nest fungi.

Geastrum rufescens and *G. triplex* are the common earthstar fungi. The rare *Geastrum* *fornicatum* and *Myriostoma coliformis* where the inner peridium buldges out and rests on outer peridium on several short stalks are among the noteworthy earthstards occuring in temperate forests. The puffballs are represented by genera like *Calvatia*, *Lycoperdon* and *Bovista*. *Lycoperdon pyriforme*, *L. perlatum*, *L. xanthospermum* ; *Bovista nigrescens* and *Calvatia caelata* are usually common on soils, grasslands, rotting wood or even on living tree trunks. *Cyathus stercoreus*, *C. straitus* with black peridioles are common birds nest fungi in tropical to subtropical zones. Also growing gregariously on plant debris are monotypic genera *Nidula* and *Nidularia*. Stinkhorns with their foetid odour are represented very poorly in W. Himalayas. *Phallus impudicus*, *Mutinus caninus* and *Clathrus delicatus* are seen growing near the bamboo culms only in the tropical zones.

CONSERVATION OF FUNGI

The fungi form one of the largest kingdom of organisms. It is necessary therefore, to ensure their full representation internationally under the umbrella organisation of IUCN-SSC.

Under the criteria for including plants in Appendix-I (species included in the appendix-I become protected by the signatory countries under the articles of the conservation) criterion 7 mentions for small selection of the threatened lower plants. Lower plants (mosses, lichens and particularly algae and fungi) have been badly neglected by conservationists, probably due to limited knowledge about their conservation status. Documentation is necessary about both their wild populations and their conservation requirements before the fungal flora can be subdivided into a rare versus the endangered species.

There are problems which on the whole are not experienced within many other large groups of organisms. For example, Fungi may occur at certain times of the year (August-September) and there may be gaps when fruiting does not occur. One either has to be at the right place at the right time or the potential rarity must be recognised by those unfamiliar with it and have it identified by an expert before decompositions take place.

This all has howerver not deterred some European countries and they have just begun to realise the need for preventing extinction of species of fungi. The recently formed "European Council for Conservation of Fugi" consists of official representation of all the European countries. Some of the countries which have published Red Data lists on macrofungi are : Federal German Republic (Benkert, 1982 ; Winterhoff, 1984); Poland (Wojewoda & Lawrynowicz, 1986); Finland (Rassi & Vaisanen, 1987); Norway (Hoiland, 1988) and Sweden (Hallingback, 1988). Arnolds (1989) has published more recently Red Data list where he considered that 28% of the larger fungi are threatened in Netherlands.

Unfortunately there is no uniformly accepted agreement on how to define threatened, endangered fungi, etc., although Rassi & Vaisanen (1987) have tried to define the categories in which fungi can be placed meaningfully. Even the term extinct is often in appropriate as some species thought to have been lost from the flora mysteriously reappear. The picture of rarity is also complicated because it brings together species which are rare because of their distributional patterns (Lange ; 1974) and those now rare because of human activities. For example, the common mushroom is becoming rare in its old habitats due to the nutrification but is a wide spread and common fungus at other places. It appears that the habitat preferences and species distribution are so significantly linked that it would be imperative to conserve habitats first compared to the efforts at this stage of producing Red Data lists. And further, the Red Data lists proposed for some European countries are only for macrofungi while there are *no chances* of such lists being prepared for microfungi which constitute about 50% of the total flora.

Factors responsible for loss of diversity and some measures :

1) India with such a huge latitudinal range with many contrasting topographies and very many distinct vegetational communities, make it difficult to comprehend a Red Data list which would be meaningful. Perhaps a better approach under the persent conditions would be to produce Red Data lists for specific areas and thus identify fungal habitats which are under threat. The habitats good for one group (macrofungi) should also be good for other (microfungi).

2) Attempts should be made to control the harvesting of wild mushrooms especially for commercial purposes. The preparation of a code of conduct for collections and issue of licence/ brochures for picking up the wild mushrooms will help to some extent.

3) Raking the leaf-needle away exposes the mycelium and button stages of many wild mushrooms and endangers the survival of many species at site.

4) One of the most important factor is extensive deforestation leading to wide scale destruction of many of the natural and seminatural habitats and exposes the fungi, as much as any other indigenous fauna and flora, to risk. This is responsible for the loss of the unique ectomycorrhizal flora, associated particularly with Oaks and Pines, and also the hosts of many parasitic fungal species. The largest number of threatened species are Agarics (mushrooms and toadstools) and nearly half of them are ectomycorrhizal species. In india about 30% of the species of Agarics are ectomycorrhizal. A possible solution is preservation of forests by establishing National Parks and Biosphere reserves in different biologically rich and natural areas of the country. By conserving a mosaic of habitats in healthy states, we will not only provide congenial environments for a full range of fungi, both large and small, but also for the insects and other invertebrates which depend on them.

5) The paucity of information on Indian mycoflora poses a problem in the design of conservation measures. One of the main problems lies in lack of local expertiese and the contacts between the various mycologists. The training of mycologists is a contentious issue, as the few universities, giving courses in Mycology, concentrate only on the economically important species particularly human and plant pathogens. A broad based Mycology curriculum in Indian universities, therefore, needs to be developed through conferences, workshops in association with national scientific organisations.

6) Lack of data on the occurrence with detailed distribution maps, substrates and ecology of the fungi is the main hurdle before any serious consideration of conservation status of any fungal species can be made. There are no studies in Indian Mycoflora comparable to the exhaustive work of Arnolds (1981, 1982), Wilkin, Ellis and Harley (1937). Wilkins & Patrick (1940) and Gilbertson & Ryvarden (1987). Works such as these will allow a rapid assessment of the occurrence and the general distribution of these fungi. Our knowledge of a species rarity and therefore, whether it is worthy of protection should not be based on little more than hunches and personal ideas.

7) "Cross off Cards" for larger fungi (Discomycetes, Gasteromycetes, Aphyllophorales, Pyrenomycetes, Agaricales), much the same as those used by Phanerogamic botanists based on the foray records and herbarium materials (Whalley & Watling, 1977) can also be used for preparing maps. With these maps, we will atleast be able to make the first attempt to ascertain the rarity of a particular fungus. This information, coupled with the extensive data base at national fungal Herbaria, will enable us to develop and modernise the approach for conservation. Soon it will be possible to prepare species lists for various habitats either to indicate their characteristic species or to help in saving sites of particular interests or even to identify new sites, which should be considered for conservation.

8) So far, conservation measures are limited to animals and higher plants with no policies or measures for the lower groups of plants, especially fungi. Fungi, unfortunately, are treated as curiousities by many conservationists, just as their role in nature is frequently given only lip service by other natural disciplines.

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